DOCUMENT RESUME

ED 245 236 SE 044 670

AUTHOR Loyd, Brenda H.; Sebastian, Ken
TITLE The Effects of Sex and Ability on Performance in Mathematics Skill Areas.
PUB DATE Feb 84
NOTE 17p.; Paper presented at the Annual Meeting of the Eastern Educational Research Association (West Palm Beach, FL, February, 1984).
PUB TYPE Reports - Research/Technical (143) -- Speeches/Conference Papers (150)

EDRS PRICE MF01/PC01 Plus Postage.
DESCRIPTORS *Academic Ability; *Algebra; Arithmetic; *Geometry; High Schools; *Mathematics Achievement; Mathematics Education; *Secondary School Mathematics; *Sex Differences
IDENTIFIERS American College Testing Program; *Mathematics Education Research

ABSTRACT

It has been suggested that males perform better than females in mathematics after ninth grade because more males than females enroll in advanced mathematics courses in high school. However, factors other than enrollment may be involved. Therefore, this study investigated whether the performance of males (N=500) and females (N=500) was different in each of four content areas (arithmetic operations and reasoning, beginning algebra, geometry, and advanced algebra) and whether the performance of these students was differentially affected by their ability level in each of the four content areas. Achievements in the four areas was determined from 30 mathematics items administered to the students as part of the regular administration of the American College Testing Program (ACT) assessment. Four ability levels were also established based on the scaled total score of the ACT assessment. Although the results of the study present a somewhat mixed picture, they raise the possibility that overall performance on mathematics achievement scores for males and females may be related to the content area from which items are drawn. However, further study is needed to substantiate these findings and clarify reasons for differences between males and females in mathematics. (JN)

**********
* Reproductions supplied by EDRS are the best that can be made *
* from the original document. *
**********

ED245936

U.S. DEPARTMENT OF EDUCATION
NATIONAL INSTITUTE OF EDUCATION
EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)
☑ This document has been reproduced as received from the person or organization originating it.
☐ Minor changes have been made to improve reproduction quality.
• Points of view or opinions stated in this document do not necessarily represent official NIE position or policy.

# The Effects of Sex and Ability on Performance in Mathematics Skill Areas

Brenda H. Loyd

and

Ken Sebastian

University of Virginia

Paper presented at the annual meeting of the Eastern Educational Research Association. West Palm Beach, February 1984.

"PERMISSION TO REPRODUCE THIS MATERIAL HAS BEEN GRANTED BY
Brenda H. Loyd
TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)."

SE044670

# The Effects of Sex and Ability on Performance in Mathematics Skill Areas

## Abstract

After ninth grade, males generally perform better than females in mathematics, perhaps because more males than females enroll in advanced mathematics courses in high school. However, other factors may also be involved. This study of ACT Assessment performance by 1000 eleventh and twelfth grade students examines the relationship between general ability and mathematics performance, and by comparing performance in four distinct mathematics skill areas.

# The Effects of Sex and Ability on Performance in Mathematics Skill Areas

Brenda H. Loyd

and

Ken Sebastian

University of Virginia

## Introduction

Sex differences in mathematics achievement have received much attention in current research literature and periodicals. Reviews of such research (Fennema, 1974; Badger, 1981) have attempted to reach some consensus on the relationship between sex and mathematics performance, but the results have not been consistent. Research does, however, seem to indicate a clear change in mathematics performance with age. Performance in mathematics by males and females appears generally equivalent up to ninth grade, after which males perform better than females (Mullis, 1975; Wilson, 1974; Wood, 1976).

Fennema & Sherman (1977) suggest that the primary difference in mathematics achievement for males and females by twelfth grade is the smaller number of higher level mathematics courses selected by females than males at the high school level. However, in many of the studies the ability level and range of performance have varied widely,

leaving open the possibility that the relationship between the sexes may vary with ability. Even when research has led to successful description of this relationship, it has often not been helpful in determining why differences between the sexes in mathematics performance occur when they do, or suggesting how instruction could be modified to promote maximum math achievement for both sexes.

In an effort to add information to this body of research, two potential sources of variation between the sex groups were selected for study. The first was the ability level of the students; the second was the skill area of mathematics measured.

## Method

The students selected for study were eleventh and twelfth grade students. Students at these grade levels have normally already taken some if not all of the higher level mathematics classes necessary to graduate from high school and/or to meet college entrance requirements.

Mathematics skill area measures were developed from the Mathematics Usage section of the ACT Assessment, a nationally standardized college entrance exam. The Mathematics Usage exam assesses mathematical reasoning and problem solving, and the items used to measure these abilities are related to mathematics courses usually taught at the high school level.

Four categories of items were determined. The first

category was Arithmetic Operations and Reasoning; it included items measuring the use of averages, percentages, and common fractions and decimals, topics which would most likely have been presented in general math classes. The second category was Beginning Algebra; it included items which measured solutions of linear equations with one unknown, and simple algebraic factoring, topics which are common to first year algebra courses. The third category was Geometry; it included items on topics usually presented in a high school geometry course. The fourth category was Advanced Algebra; it included items on factorization of polynomials, solution of systems of equations, and exponents, topics which are often taught in a second high school algebra course.

The Geometry and Mathematic Operations and Reasoning categories each contained seven items, while both Algebra sections contained eight items. The scores on each set of items became the dependent variables.

The study addressed the following questions:

1. Is the performance of male and female students different within each of the four content areas?
2. Is the performance of male and female students differentially affected by the ability level of the students within each of the four content areas?

## Procedure

The 30 math items were administered to a sample of 1000 high school students, 500 males and 500 females, as part of the regular administration of the ACT Assessment.

Four ability levels were established on the basis of the scaled total score on the ACT Assessment. This total scaled score is based on performance across four tests: Language Usage, Mathematics Usage, Social Studies, and Natural Sciences. The highest ability level included students who nationally were in the top 10 percent of those taking the ACT Assessment. A middle ability included those in the middle 60 percent with the upper 30 percent in the second level and lower 30 percent in the third level. The low ability level included those students from the lowest 30 percent.

## Analysis

The data were analyzed by a multivariate analysis of variance procedure. Each significant multivariate analysis was then followed up by four two-factor analysis of variance procedures, in which the first factor was sex and the second factor was ability. A separate procedure was performed for each of the four dependent variables representing the four different areas of mathematics.

## Results and Discussion

The results of the analyses revealed discrepancies on the scaled ACT Assessment scores for the four skill areas of mathematics. In the multivariate analysis, the two main

effects, sex and ability, were significant ($p<.01$). The sex by ability effect was not statistically significant. In the four follow up two factor analysis of variances, the sex by ability interaction were non-significant; however, the effect of ability for all skill levels was significant ($p<.001$). Overall, males performed better than females in all mathematic skill areas. In the Arithmetic Operations and Reasoning, Geometry and Advanced Algebra subgroups, the effect of sex was significant ($p<.020$, $p<.001$, and $p<.039$ respectively). Beginning Algebra was the only mathematic skill subgroup in which the effect of sex was not statistically significant.

The results of this study present a somewhat mixed picture. The lack of a significant sex difference for the Beginning Algebra subtest compared to the significant sex differences for the Geometry and Advanced Algebra might suggest that among those students in high school preparing to go to college differences between male and female performance might be related to differential enrollment in advanced mathematics class. However, the significant difference between males and females for the Arithmetic Reasoning subtest would not support this explanation. It may also be that differences between males and females may be related to spatial concepts required in such areas as Geometry. However there is not evidence from this study to suggest that all differences could be related to differences in the spatial concepts presented in each subtest.

The results of this study do raise the possibility that overall performance on mathematics achievement scores for males and females may be related to the mathematics skill area from which items are drawn. However, further study is needed to substantiate these findings and clarify reasons for differences between males and females in mathematics.

Table 1

Summary of Multivariate

Analysis of Variance

| Effect | df | Wilks Lambda | Approx. F | Signif. of F |
|---|---|---|---|---|
| Sex by Ability | 12 | .99 | 1.19 | .29 |
| Ability | 12 | .34 | 109.56 | .01 |
| Sex | 4 | .89 | 30.18 | .01 |

Table 2

Summary of ANOVA for

Arithmetic Operations and Reasoning

| SV | df | MS | F | Signif. of F |
|---|---|---|---|---|
| Sex | 1 | 10.81 | 5.44 | .02 |
| Ability | 3 | 408.56 | 205.54 | .001 |
| Sex by Ability | 3 | 1.73 | .87 | .46 |

Table 3

Summary of ANOVA for

Beginning Algebra

| SV | df | MS | F | Signif. of F |
|---|---|---|---|---|
| Sex | 1 | 3.94 | 1.61 | .21 |
| Ability | 3 | 809.52 | 330.37 | .001 |
| Sex by Ability | 3 | 4.63 | 1.89 | .13 |

Table 4

Summary of ANOVA for

Geometry

| SV | df | MS | F | Signif. of F |
|---|---|---|---|---|
| Sex | 1 | 15.75 | 11.25 | .001 |
| Ability | 3 | 278.60 | 199.03 | .001 |
| Sex by Ability | 3 | 1.14 | .81 | .49 |

Table 5

Summary of ANOVA for

Advanced Algebra

| SV | df | MS | F | Signif. of F |
|---|---|---|---|---|
| Sex | 1 | 10.97 | 4.27 | .04 |
| Ability | 3 | 770.08 | 299.49 | .001 |
| Sex by Ability | 3 | 3.35 | 1.30 | .27 |

Table 6

Means and Standard Deviations
for Mathematics Skill Areas
by Sex and Ability Grouping

| | | Arithematic Operations | Beginning Algebra | Geometry | Advanced Algebra | Total |
|---|---|---|---|---|---|---|
| Ability Group | Mean | 2.59 | 1.69 | 2.38 | 1.91 | 8.56 |
| 1 (N=319) | SD | 1.56 | 1.24 | 1.05 | 1.39 | 3.19 |
| 2 | Mean | 3.83 | 3.13 | 3.12 | 3.65 | 13.71 |
| (N=321) | SD | 1.47 | 1.75 | 1.22 | 1.81 | 4.11 |
| 3 | Mean | 4.90 | 4.82 | 4.02 | 5.16 | 18.91 |
| (N=251) | SD | 1.31 | 1.80 | 1.27 | 1.69 | 4.20 |
| 4 | Mean | 6.06 | 6.45 | 5.45 | 6.58 | 24.54 |
| (N=109) | SD | 0.95 | 1.22 | 1.29 | 1.32 | 3.27 |
| Sex | | | | | | |
| Males | Mean | 4.26 | 3.69 | 3.66 | 4.18 | 15.79 |
| (N=500) | SD | 1.76 | 2.25 | 1.59 | 2.29 | 6.63 |
| Females | Mean | 3.63 | 3.23 | 3.06 | 3.40 | 13.32 |
| (N=500) | SD | 1.82 | 2.16 | 1.39 | 2.13 | 6.02 |

## References

Badger, N.E. Why aren't girls better at math? A review of research. Educational Research, 1981, 24, 11-23.

Fennema, E.H. Women and girls in mathematics, Educational Studies in Mathematics, 10, 389-401, 1979.

Fennema, E.H. and Sherman, J.A. Sex-related differences in mathematics achievement and related factors: a further study. Journal for Research in Mathematics Education, 1978, 9, 189-203.

Mullis, I.V.J. Educational Achievement and Sex Discrimination. National Assessment of Educational Progress, Denver, Colorado, 1975.

Wood, R. Sex differences in mathematics attainment of GCE "O" level. Educational Studies, 2, pp. 141-160.